Research Article

Effect of Levels of Concentrates on Carcass Characteristics, Meat Traits and By-Products in Crossbred Brahman Cattle

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Abstract | Twelve Brahman crossbred growing bulls, divided into three groups, were fed three diets; 100% concentrate diet (A), a 1:1 mixed diet on dry matter of Urea-Molasses-Straw (UMS) and concentrate diet (B) and sole UMS diet (C), respectively, to evaluate the effects of concentrate level on slaughterhouse by-products, carcass characteristics and meat traits. The animals were fed for a period of 90 days and three animals from each group were slaughtered at the end of the trial. The results indicated that yield of edible and inedible by-products had no significant difference among diet groups. When expressed in percentage of live weight, hides, shanks, liver and empty stomach were greater (P<0.05) in animals fed diet C compared to those in diet A and B, whereas no difference was found for those between the last two diets. There was no variation between diet A and B in carcass weight, while it was significantly (P<0.01) lower in diet C. Among carcass traits, hotdressing percentage, kidney-pelvic-heart fat, abdominal fat and back fat thickness increased linearly (P<0.01) with the increased level of concentrate in diets, while *Longissimus* muscle area did not vary among diet groups. Dietary treatments had no influence (P>0.05) on the content of moisture and protein in meat, but concentrate supplementation reduced ash content and increased the amount of fat (P<0.01) compared to UMS group. Therefore, considering carcass and meat traits, a mixed diet of concentrate and UMS may be fed to Brahman crossbred bulls for fattening.

Keywords | Brahman crossbred, Concentrate, Dressing percentage, Meat traits

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INTRODUCTION

Beef is widely available source of animal protein in Bangladesh. The annual meat production in Bangladesh is 3.60 million metric ton, where the beef contributes 60.6% of the value (DLS, 2013; Hamid et al., 2008). The feed consumed by cattle can change beef quality through its effect on the quantity of energy of feed available to the animal and through the nutrient composition of the feed (Fluharty et al., 2009). These two factors are inevitably and intimately linked because different feed types vary in the amount of available energy as well as nutrient composition. When compared between forage-based with grain-based feeding, forage deemed the lower energy diet and grain-based feed the higher energy diet. It is often difficult to isolate the true effects of forage and grain feeding on beef quality. As a result, feed type differences have been confounded with plane of nutrition effects, such that cattle fed the higher energy diet (usually the grain-based diet) have been heavier and fatter in comparison with those fed the forage-based diet (Muir et al., 1998; Gregory et al., 1994). They concluded that there is little scientific justification for the claim that grain feeding is necessary to produce high quality beef. Beef of comparable quality can be obtained from cattle finished on forage-based diets provided that acceptable carcass weights and degrees of finish can be achieved at a young age.

Beef consumption depends on different factors like consumer preference, nutritive value of different cuts of the beef carcasses. Based on consumer's choice for beef quality feeding regime in addition to animal age should be identified (Huque et al., 2005). There is variation in chemical compositions of different wholesale cuts of the carcass of indigenous cattle as well as in quality of meat according to age (Lubna, 2008). The slaughterhouse by-products may be divided into edible and inedible by-products. Animal by-products also serve as an extra means for packers to earn revenue or as a cushion to cover losses, when the cost of purchasing the live animal exceeds the selling price of the carcass. Recent crossbreeding program by Brahman sire has produced an increased number of crossbred cattle for beef production in Bangladesh. However, literature regarding carcass characteristics and beef quality of these Brahman X Local crossbred cattle is scanty in Bangladesh. Therefore, the present study was conducted with the objectives to evaluate the effect of feeding concentrate on slaughterhouse by-products, carcass characteristics and meat traits of Brahman crossbred growing bulls.

MATERIALS AND METHODS

Animals, Feeding and Management

Twelve Brahman X Local crossbred growing bulls of 18.5 to 21.5 months of age having an average live weight of 343.0±20.0 kg were selected, kept in individual stalls with separate feeding and watering systems under a tin shed housing and de-wormed with anthelmentics immediately before the start of feeding experimental diets. The animals were divided into three equal groups each with four animals and similar average live weight. Keeping a group on the 100% UMS diet (C), the animals of other two groups were fed either with a 1:1 mixed diet on dry matter basis (B) of the UMS and a conventional mixed concentrate containing 39% wheat bran, 54% crushed corn, 2% crushed khesari, 3% soybean meal, 1% limestone and 1% common salt; or with 100% mixed concentrate diet described above (A). UMS diet was composed of urea, molasses and rice straw at a ratio of 3:15:82 on dry matter (DM) basis (Huque and Talukder, 1995). Compositions of experimental diets are given in Table 1.

Measurement of Carcass Characteristics

After 90 days of feeding trial, three animals from each dietary treatment were randomly selected for sacrificing to determine carcass characteristics and meat traits, while they were continued to raise on the experimental diets following the trial. Final weight of each selected animal was taken at 7.00 am of the sacrificing day after 14 h of fasting except water. All animals were brought to a place of slaughter, laid down gently so as to not injure it and sacrificed by a swift, deep incision with a sharp knife on the throat, cutting the jugular veins and carotid arteries of both sides but leaving the spinal cord intact. After complete bleeding, skin and internal organs were removed. Weights of blood, head, legs, hide and internal organs (heart, lungs, liver, kidney, sexual organs, rumen, reticulum, abomasums, small and large intestine) were measured immediately after evisceration. Digestive tract was emptied before weighing. Having no facility for chilling of beef carcass after completion of pre- and post- sacrifice measurements, the data on carcass characteristics according to FAO (1991) were expressed based on hot carcass. Whole carcass, keeping on a polythene sheet on plane land, was manually halved with choppers and knives at the 12^{th} and 13^{th} rib interface.

Carcass traits included hot carcass weight, hot dressing percent (HDP), yield of forequarter and hindquarter, *longissimus* muscle area (LMA) at the 12^{th} rib, fat thickness over the rib eye at the 12th rib, fat from kidney, pelvic and heart (KPH, %) and abdominal fat. Fat cover thickness was estimated as from the left side of the carcass by exposing the *longissimus* muscle at the region between the 12th and 13th rib, through the mean of three equidistant points, by a Varnier caliper and percentage of KPH yield was estimat ed. For measuring LMA, the hot carcass was split between the 12th and 13th ribs. From the cross section, the area was traced onto an acetate paper and from the weight-area

Table 1: Chemical composition of three experimental diets

Nutrient composition	Diet		
	A (100% concentrate)	B (50% concentrate + 50% UMS)	C (100% UMS)
Dry matter (kg/100 kg feed)	90.1	75.7	61.3
Crude protein (% of DM)	13.0	11.4	9.75
Organic matter (% of DM)	92.5	88.0	83.5
Acid detergent fiber (% of DM)	23.0	33.5	43.9
Ash (% of DM)	7.47	12.0	16.6
Estimated Metabolizable Energy* (MJ/kg DM)	12.3	9.65	7.04

* The ME value of each ingredient was estimated using the equation; ME (MJ/kg DM) = 13.50 + 0.263 EE% - 0.133 ash % - 0.136 ADF% (MAFF, 1984); The ME value of concentrate mixture (100%) was calculated using the estimated ME value of all ingredients; ME value of UMS (100%) was calculated assuming 6.2 MJ ME /kg DM of straw (Khan, 2008) and 13.0 MJ ME /kg DM of molasses (Dugmore, 1995); ME for diet B= Average of diet A and C= 9.65 MJ ME /kg DM of diet

Table 2: Yield of by-products and relationship with live weight in Brahman crossbred bulls fed on different diets

Parameters	Weight (Kg)					Percentage of live weight				
	Diet			SEM	P-value	Diet			SEM	P-value
	A	B	C			A	B	C		
Inedible by-products										
Blood	14.4	14.6	13.3	0.31	0.18	3.26	3.26	3.68	0.107	0.18
Hides	34.8	36.6	32.4	0.79	0.07	7.85[b]	8.18[b]	8.94[a]	0.190	0.02
Testes	0.60	0.76	0.59	0.043	0.23	0.14	0.17	0.16	0.0096	0.39
Penis	0.53	0.69	0.64	0.031	0.07	0.12[b]	0.15[a]	0.18[a]	0.0095	0.016
Four shanks	8.04	7.69	8.50	0.22	0.38	1.82[b]	1.72[b]	2.36[a]	0.117	0.023
Edible by-products										
Liver	3.89[b]	4.50[a]	3.93[b]	0.12	0.045	0.88[b]	1.00[a]	1.09[a]	0.034	0.0103
Heart	1.34	1.24	1.18	0.04	0.16	0.30	0.28	0.31	0.008	0.18
Kidney	0.66	0.70	0.64	0.016	0.24	0.15	0.16	0.18	0.0056	0.07
Lungs with trachea	4.27	4.41	4.33	0.23	0.97	0.97	0.99	1.20	0.070	0.36
Spleen	0.71	0.69	0.59	0.03	0.18	0.16	0.15	0.16	0.0055	0.85
Tail	1.23	1.14	1.26	0.06	0.73	0.28	0.26	0.35	0.020	0.10
Empty stomach	12.8	13.4	13.1	0.23	0.68	2.90[b]	2.99[b]	3.63[a]	0.128	0.009
Empty intestine	8.79	9.15	8.50	0.19	0.41	1.99	2.04	2.35	0.074	0.07
Head with horn & hide	19.6	19.2	17.6	0.57	0.37	4.43	4.30	4.87	0.147	0.28

A= 100% concentrate; **B**= 50% Concentrate + 50% UMS; **C**= 100% UMS; **SEM**= Standard Error of means; [a] and [b] Values having different superscripts in the same row differ significantly

relationship of the acetate paper the average area of each single 'eye' was estimated (Rahman, 2007). Therefore, *longissimus*/*eye muscle area* (cm^2) = (Weight of acetate paper for total *eye muscle area* / Weight of acetate paper for one cm^2).

Carcass weight was measured in kilogram. It was excluded from the weight of head, blood, horns, hooves, stomach, rumen content, intestine, gall bladder, hides, genital organ and feet. After completion of sacrificing, various slaughterhouse edible and inedible by-products were collected scientifically and weighed. The percentage of by-products on live weight (LW) was calculated. HDP was estimated using the following formula:

*HDP= Weight of the hot carcass / Live weight during sacrificed *100*

Four cuts were collected from each carcass sample; chuck, rib (between the 10th and 12th rib), loin and round. A quantity of 500 g of meat samples were taken from each cut of each carcass in airtight poly bags and immediately frozen at -20°C for further analysis in laboratory. Proximate composition such as dry matter (DM), ether extract (EE), crude protein (CP) and ash were determined according to AOAC (1995). All the samples were analyzed in duplicate and mean values were recorded. Data on percentage of moisture, CP and ash of chuck, rib, loin and round cuts were pooled to evaluate the dietary treatment effect. EE was determined from only rib cut (*Longissimus* muscle).

Statistical Analysis

The data were analysed in an ANOVA of a completely randomized design using Generalized Linear Models Procedure with SAS software (SAS, 2003) and significant differences in the response of the diets were determined. Duncan's multiple-range test was used to compare the treatment means (Steel and Torrie, 1980) for different parameters.

RESULTS AND DISCUSSION

Yield of By-products

The weight of various by-products and their percentage in function of LW are shown in Table 2. The result shows that no significant differences ($P>0.05$) were observed in the weight of various edible and inedible by-products among diet groups except liver, which was greater ($P<0.05$) in diet B compared to other diets. When expressed in percentage of LW, hides, four shanks, liver and empty stomach were greater ($P<0.05$) in animals fed diet C compared to those in diet A and B, whereas no difference ($P>0.05$) was found between the last two diets except liver ($P<0.05$). The percentage of other edible and inedible by-products was slightly higher in the animals on diet C than those of diet A and B. Though, the average initial body weights of each of 3 diet groups were similar, animals fed diet C achieved less final weight due to slower growth rate (205 g) compared to other two diets (954 and 873 g) (Rashid et al., 2015). Numerically higher percentage of almost all edible and inedible by-products of the animals in diet group C might be due to the lesser slaughter weight in that group in relation to the animals of diet A and B.

Ali et al. (2013) reported that the yields of hides, testes, penis, heart, kidney, empty stomach and head of indigenous cattle were similar to those of diet C found in this study. They also found a higher percent of blood, liver, spleen and empty intestine. Huque et al. (2005) observed similar yield of blood (3.3%) and liver (1.12%), higher yield of skin (11.7%) and lower yield of head (3.77%). Different forage to concentrate ratio in diets did not have influence on the percentage of 4 feet, head and hides (Gabriella et al., 2008) and the yield of hide (8.98%) and 4 feet (2.06%) were consistent with the present results. In another study, Fadol and Babiker (2010) did not find any difference in non-carcass components of Sudan Baggara zebu bulls fed on *ad lib* or restricted feeding. They also reported that most of the non-carcass components were similar to the findings of diet C.

Carcass Yield

Live weight, hot carcass weight and hot dressing percentage of slaughtered animals are given in Table 3. Concentrate supplementation in diets resulted in higher (P<0.01) final live weight and hot carcass weight compared with the animals fed UMS diet. Hot dressing percentage of animals linearly increased (P<0.01) with the increased level of concentrate in diets. Animals receiving the 100% concentrate diet showed highest dressing percentage as a consequence of highest daily gain (954g) and animal receiving the 100% UMS diet showed lowest dressing percentage as a consequences of lowest daily gain (205g) whereas 50%concentrate: 50% UMS diet showed intermediate value in dressing percentage. In ruminants, maintaining the digestive organs can take as much as 40-50% of the energy and 30-40% of the protein consumed in a day. Forage diets increase the weight of the digestive tract, because more undigested feed remains in each segment of the digestive tract and grain-based diets result in decreased organ weights compared with forages, because grains are 80-100% digestible, and have a much smaller particle size, which allows them to have a faster rate of digestion and passage through the digestive tract (Fluharty et al., 2009). The result is that grain is more digestible than forage, plus it decreases an animal's maintenance requirement by resulting in less digestive organ mass, leaving more nutrients for muscle growth and fattening. These statements were supported by this study.

The variations observed in dressing percentage for animals fed different diets may also result from changes in gastrointestinal tract weight (Duarte et al., 2011). Animals receiving 50% concentrate diet or 100% UMS diet may present higher viscera weights due to increased gastrointestinal fill associated with greater fibre intake, which leads to reductions in dressing percentage. These results are similar to others reported in the literature, in which dressing percentage increased linearly as forage level decreased (Duarte et al., 2011; Pereira et al., 2006). Supporting our study, Gionbelli et al. (2012) reported improved (P<0.05) cold dressing percentage in Nellore heifers fed 45% concentrate diet compared to 22.5% concentrate diet. Feeding 50% concentrate diet resulted similar dressing percentage in Brahman crossbred bulls (55.7%), RCC bulls (55.6%) and Nellore-Angus crossbred cattle (55.2%) (Roy et al., 2013; Fugita et al., 2012), which are consistent with the present results. Rodrigues et al. (2013) observed similar hot carcass yield (56.5%) in 20 month old bullocks fed 75% concentrate diets in feedlot. However, dressing percentage was not affected by forage to concentrate ratios (Gabriella et al., 2008) and *ad lib* or restricted feeding

Table 3: Carcass yield characteristics of Brahman crossbred bulls fed on different diets

Parameter	Diet			SEM	P- value
	A	B	C		
Live weight at slaughter (kg)	443[a]	448[a]	362[b]	14.45	0.0003
Hot carcass weight (kg)	263[a]	250[a]	192[b]	11.22	0.0002
Hot dressing percentage (%)	59.5[a]	55.8[b]	53.2[c]	0.967	0.0013
Forequarter (%)	56.2	55.6	55.2	0.288	0.72
Hindquarter (%)	43.8	44.4	44.8	0.288	0.72
KPH (kg)	10.8[a]	7.56[b]	3.71[c]	1.05	<0.0001
KPH (%)	2.45[a]	1.69[b]	1.03[c]	0.209	<0.0001
Abdominal fat (kg)	5.73[a]	4.11[b]	2.83[c]	0.420	<0.0001
Abdominal fat (%)	1.29[a]	0.92[b]	0.78[c]	0.078	<0.0001
Fat thickness (cm)	0.64[a]	0.41[b]	0.28[c]	0.052	<0.0001
Longissimus muscle area (cm^2)	92.5	94.4	86.1	2.51	0.42

A= 100% concentrate; **B**= 50% Concentrate + 50% UMS; **C**= 100% UMS; SEM= Standard Error of means; [a, b] and [c] Values having different superscripts in the same row differ significantly (P<0.05)

(Fadol and Babiker, 2010).

No differences were observed (P>0.05) for yields of forequarter and hindquarter among diets (Table 3). The results show that forequarter yield for all diets were greater than the yield of hindquarter. Hindquarter cuts have more commercial value and, therefore, the overall reduced hindquarter yield would someway reduce the commercial value of the carcass. Our results were consistent with the results of Gionbelli et al. (2012) who did not find any difference for forequarter and hindquarter yields between 22.5 and 45% concentrate level. Higher yield of forequarter in this study compared to that reported by Gionbelli et al. (2012), which might be due to the presence of prominent hump in Brahman crossbred bulls. Roy et al. (2013) reported similar ratio of forequarter and hindquarter yield in Brahman crossbred, Pabna and RCC bulls at different ages fed 50% concentrate diet However, carcass traits and carcass yield were not influenced by concentrate level (1.0 or 1.25% of LW) in Nellore cattle (Marcondes et al., 2008).

Following the same trend in dressing percentage, yields of KPH and abdominal fat and back fat thickness were also linearly increased (P<0.01) with the increase of concentrate level, regardless of the form of expression. This could be due to the fact that concentrate diets in this study were enriched in energy, and digestibility and feed conversion efficiency were improved with the increase of concentrate level (Rashid et al., 2015). Adipose tissue synthesis requires a source of fatty acid and glycerol 3-phosphate, almost all of which comes from propionate (from glucose). When animals are fed a high concentrate diet, the amount of propionate produced increases relative to acetate and propionate is the major glycogenic fatty acid (Fluharty et al., 2009). Thus, more propionate is produced, and more glucose is produced in the liver, resulting in more net energy available to the animal fed 100% concentrate diet in this study and production of more fat. In support with our results, Ribeiro et al. (2002) observed increases in KPH of crossbred bulls as concentrate level increased and a trend for increased backfat thickness as concentrate levels increased.

The KPH and abdominal fat are waste fat, which are not consumable. Excessive external back fat and KPH fat production causes inefficiencies due to the higher energy cost of depositing fat compared with protein, and the packing industry, due to the high cost of trimming and the low price received for the fat. The highest yield of waste fat was found in 100%concentrate diet and lowest in 100% UMS diet, whereas 50% concentrate diet showed intermediate values. Similar KPH (1.9%) was found by Huque et al. (2005) in 2-3 year-old Pabna cattle fed concentrate @1% of LW and silage *ad lib*. On the similar feedlot diet (14.4% CP), the KPH were recorded by Elzo et al. (2012) as 2.26% and 2.06% for Brahman-Angus crossbred and Brahman cattle, respectively.

Gionbelli et al. (2012) found a slightly greater fat thickness in 45% concentrate diet compared to 22.5% concentrate diet. Similar back fat thickness (3.9-4.4 mm and 4.03 mm) were reported by Fugita et al. (2012) in Nellore-Angus crossbred cattle fed 50% concentrate diet and Rodrigues et al. (2013) in bullocks fed 75% concentrate diet compared to diet B. Concentrate fed heifers or steers had higher (P<0.01) fat thickness and KPH% than forage-fed heifers or steers as reported by Garmyn et al. (2010) and Duckett et al. (2013). However, Smith et al. (1984) reported that backfat thickness and the activities of several enzymes involved in lipogenesis were greater in steers fed a high concentrate diet versus steers fed a forage based diet, even though the metabolizable energy intake was higher with the pelleted forage diet.

LMA was not influenced (P>0.05) by dietary treatments. In line of these findings, no difference in LMA was detected by Fadol and Babiker (2010) between *ad lib* and restricted feeding or by Garmyn et al. (2010) between concentrate and forage-based feeding. On the other hand, Duckett et al. (2013) detected larger LMA (cm^2) in concentrate diet than forage diet. The average LMA value of three diets was similar to that reported by Roy et al. (2013) in Brahman crossbred bulls fed on 50% concentrate diet and Huque et al. (2005) in Pabna cattle fed on concentrate (@1% of LW). A fairly close LMA compared to present results was reported by Elzo et al. (2012) in Brahman-Angus crossbred cattle. Contrary to the present findings, Fugita et al. (2012) and Rodrigues et al. (2013) found less LMA in similar weighed Nellore-Angus crossbred fed 50% concentrate diet and bullocks fed 75% concentrate diet, respectively.

Table 4: Chemical composition of meat of Brahman crossbred bulls fed on different diets

Nutrient (%)	Diet			SEM	P- value
	A	B	C		
Dry Matter	25.3	25.0	25.0	0.205	0.73
Moisture	74.7	75.0	75.0	0.205	0.73
Crude protein	20.0	19.9	19.9	0.092	0.98
Fat	1.97 [a]	1.84 [a]	1.10 [b]	0.142	0.0007
Ash	0.78 [b]	0.75 [b]	1.00 [a]	0.038	0.009

A= 100% concentrate; **B**= 50% Concentrate + 50% UMS; **C**= 100% UMS; **SEM**= Standard Error of means; [a] and [b] Values having different superscripts in the same row differ significantly (P<0.05)

Chemical Composition of Meat

There were no differences (P>0.05) among dietary treatments for the content of DM, moisture and protein in meat (Table 4). Feeding 100%UMS diet significantly (P<0.01) increased ash content in meat compared to feeding either 100% concentrate or 50% concentrate diet, while last two diets did not differ. The intramuscular fat of longissimus muscle was greater in the animal fed 100% concentrate diet and 50% concentrate +50% UMS diet (P<0.01) compared to animals fed 100% UMS diet. But fat content was not varied between the former two diets. This is due to the fact that feeding diets high in readily fermentable carbohydrate (concentrate) increases the proportion of propionate produced through ruminal fermentation and increased peak insulin concentrations with increased propionate production will also lead to increased insulin secretion, which increases intramuscular fat and protein syntheses (Johnson et al., 1982).

Similar to the results of this study, Mandell et al. (1998) indicated that grain feeding increased (P<0.01) intramuscular fat content when compared with forage feeding at similar times on feed. Pasture feeding significantly decreased the intramuscular fat level in *longissimus* muscle (Dannenberger et al., 2006). Roy et al. (2013) reported similar content of moisture and CP in meat in Brahman crossbred, Pabna and RCC bulls fed 50% concentrate, which is consistent with the present results. The moisture and fat content were similar and protein content was greater in meat of natural grass grazed native Thai cattle and straw and grass-fed with 3 months concentrate-finished Brahman crossbred steers compared to our findings (Sethakul et al., 2008). These authors also stated that moisture and CP of *Longissimus* dorsi muscle were not influenced by feeding system in Brahman crossbred, but fat percentage was improved in prolonged concentrate feeding.

Table 5: Mean chemical composition of meat from different cuts of Brahman crossbred bulls

Nutrient (%)	Different cuts				SEM	P-value
	Chuck	Rib Eye	Loin	Round		
Dry Matter	25.2	25.2	25.3	24.7	0.21	0.74
Moisture	74.8	74.8	74.7	75.3	0.21	0.74
Crude protein	19.7	20.1	19.7	20.2	0.09	0.13
Ash	0.87	0.82	0.85	0.84	0.04	0.97

SEM= Standard Error of means

In Nellore steers fed 50% concentrate diet, Costa et al. (2013) found less fat content in meat. However, in relation to present study, Fugita et al. (2012) found low moisture; high CP and similar ash percentage in *Longissimus* muscle of Nellore-Angus crossbred cattle. Fadol and Babiker (2010) found no differences in moisture, CP, fat and ash component of meat between *ad lib* or restricted feeding in zebu bulls. In a review paper, Barnes et al. (2012) presented the average chemical composition of *Longissimus* muscle of different breeds, which were 73.4, 21.8 and 3.15 for moisture, CP and fat, respectively. Marino et al. (2006) detected no significant differences in chemical composition of *Longissimus* muscle of Podolian young bulls fed high or low concentrate diets.

No variation was observed (P>0.05) in chemical compositions of meat among chuck, rib, loin and round cuts (Table 5). Contrary to these findings, Lubna (2008) reported that moisture and CP content differed significantly among chuck, rib, loin and round cuts of indigenous zebu cattle of 2-3 years of age. Lubna (2008) also demonstrated that CP content was found highest in rib cut and lowest in chuck, which partially supports our findings.

CONCLUSION

Dietary treatments had nominal influence on the slaughterhouse by-products when expressed as percentage of LW, presenting numerically greater values in the animals on sole UMS diet. Brahman crossbred growing bulls receiving concentrate and UMS at a ratio of 1:1 improved most of the carcass traits than those fed 100% concentrate diet and 100% UMS diet. The concentrate supplementation did not affect moisture and protein content of meat, but increased fat and reduced ash content. Thus, a mixed concentrate at 50% as a supplement to a UMS diet may be used for better carcass and meat quality of Brahman crossbred growing bulls.

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CONFLICT OF INTEREST

There is no conflict of interest.

AUTHORS CONTRIBUTION

All the authors have equally contributed to this research.

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